AN APPARATUS AND METHOD FOR FLOOD DEFENCE

The present invention relates to an apparatus and method for water retention for use mainly, but not exclusively, for flood defence.

Domestic and commercial properties built in low lying areas may be susceptible to flooding, particularly if they are built on a flood plain. Existing flood defences to protect such properties may comprise permanent bunds or walls of fixed height but these can prevent access across the line of defence and can be unsightly. Temporary defences immediately adjacent to domestic properties are usually provided in the form of sandbags and the sealing up of doors and windows. However, these defences confine the inhabitants to their homes during the period of the flood and are severely limited by the height of the sand bags and the strength of doorways and windows to resist water pressure. Other temporary defences, on a larger (non-domestic) scale, comprise a variety of systems such as flexible tubes filled with water, stone filled gabions, strutted and sheet materials covered with an impermeable membrane, and are sited alongside river banks to protect larger areas of flood sensitive land. All such temporary devices have the dual disadvantages of only protecting a small height of flood and being labour intensive to install and dismantle.

WO 01/71099 discloses a system for flood defence having a channel shaped foundation in which is stored a barrier hinged to the foundation and folded along two internal longitudinal hinges. A shore plate covers the folded barrier and is also hinged to the foundation. To erect the barrier, the shore plate is folded out and the barrier is then folded out to form a vertical structure with the shore plate locked to the lower of the two internal hinges of the barrier to support the barrier. This system requires the weight of the shore plate and the barrier to be supported as they are rotated and folded out and the barrier needs to be temporarily held whilst the shore plate is locked to it to support the barrier. The erection of such a barrier would be time consuming.

An object of the present invention is to provide an apparatus and method

for flood defence which alleviates at least one of the above mentioned problems.

According to one aspect of the present invention there is provided an apparatus suitable for flood defence comprising at least one slab unit rotatable about an axis between lowered and raised positions, the at least one slab unit comprising at least part of a barrier for water retention when in its raised position, characterized in that the at least one slab unit is substantially balanced about the axis.

By making the at least one slab unit substantially balanced about the axis, the slab unit can be rotated manually into its raised position without having to rely on a powered driving means which may, for example, require either electrical or hydraulic power supplies or a combination of both. The slab unit may be finely balanced for movement by fingertip action. The slab unit may weigh several tonnes and can be balanced in such a manner that it can be adjusted to be lifted with one hand from the lowered (e.g. horizontal) position to the raised (e.g. vertical) position. Thus, only a single average strength adult is required to raise or lower the slab unit although two people should be used to conform to safety requirements. The use of gravity in the manner of counterbalancing the slab employs a force of nature to assist manual erection. Hence countermeasures to resist gravity, such as props, are not necessarily required.

A flood barrier of a substantial height can thus be quickly erected / taken down by use of the apparatus. The apparatus forms at least part of an active defence when the or each slab unit is in its raised position. In addition, the view from any property being protected by a flood barrier comprising the apparatus is only temporarily obstructed whilst the or each slab unit is in its raised position. The apparatus can be used for a range of applications for the protection of domestic, commercial, and public buildings, industrial sites and flood sensitive land whether from threat by river or sea and in both rural and built-up areas and provides a lack of unnecessary inconvenience to the owner of the property/land to be protected.

The apparatus provides a permanent demountable defence.

The apparatus may include a base wherein the at least one slab unit is rotatable relative to the base.

The apparatus preferably includes sealing means for forming a seal when the at least one slab unit is in its raised position. The sealing means may form a seal between the at least one slab unit and the base when the at least one slab unit is in its raised position.

There may be at least one abutment adjacent the slab unit. The sealing means may be arranged to form a seal between the slab unit and the adjacent abutment when the slab unit is in its raised position.

The apparatus preferably includes a plurality of said slab units rotatable about said axis. The sealing means may be arranged to form a seal between adjacent slab units when the slab units are in their raised position.

When a slab unit is deployed in its raised position, a significant portion of the height of the slab unit may be positioned downwardly of the axis whereby hydrostatic pressure deployed from water being retained by the slab unit compresses the seal. In order that water pressure alone keeps the seal(s) closed naturally, substantially at least one third of the height of the slab unit is positioned downwardly of the axis. This determines the extent of the effective active height possible without other measures being introduced (for example propping) to resist imbalanced water forces.

The pressure of water retained by a raised slab unit maintains a positive pressure against seals both between the slab unit and the base (e.g. horizontally) and between a slab unit and an adjacent slab unit or abutment (e.g. vertically) and employs the forces of nature in a positive and natural manner to ensure the safe closure and effectiveness of the water seals. Thus sealing countermeasures such as props which have to be tightened a set amount to ensure that a seal resists water and remains closed, is not necessarily required.

In order that the slab units may be raised individually, the means of sealing between a said slab unit and an adjacent abutment or slab unit

preferably comprises at least one removable portion. The removable portion may comprise a removable board. There may be wedging means for urging the removable board against at least one seal. The wedging means may comprise a scissor action device which is able to provide a wedging action. The device may comprise any one of a variety of clamping methods such as crossed metal tapered flats in "scissor" form, or loose plates held on captive bolts and tightened with captive nuts.

The sealing means between a said slab unit and an adjacent abutment or slab unit preferably forms a continuous seal with the sealing means between the at least one slab unit and base when the at least one slab unit is in its raised position.

There may be at least one strut or prop for supporting at least one said slab unit in its raised position. The strut may be adjustable in length and may be used to tighten the slab unit against the seal between the slab unit and the base when the slab unit is in its raised position. The strut may be removable.

The apparatus may include locking means for locking at least one said slab unit in its lowered and/or raised positions.

The apparatus provides a raised flood barrier by unlocking the at least one slab unit and simply rotating the at least one slab unit to its raised position, locking the at least one slab unit in its raised position, inserting the sealing means between the at least one slab unit and abutments and, if necessary, inserting struts. This operation can be conducted in a matter of minutes by unskilled labour and unskilled labour just need to be shown once how to erect/lower the flood defence.

The slab unit may comprise different portions with different densities and this enables the slab unit to be balanced when the slab unit is not centrally distributed relative to the axis. This may be achieved by the slab unit having means such as a bracket, or rack, or racking holding or supporting at least one balancing weight. An appropriate number of unit balancing weights may be included in order to achieve fine balancing of the slab unit. To enable the slab

unit to be lifted with one hand, a weight may be moved along a beam attached to the slab unit until the slab unit tilts. The position of the weight on the beam indicates the weight of the slab unit on the opposite side of the axis. A suitable slab unit may be approximately 3 to 5 metres long and 1.5 to 3 metres wide. In a preferred embodiment for a domestic property, the slab unit is approximately 3 metres long, 1.5 metres wide and 15 centimetres thick. This is a typical size for ease of transport to the site and erection. The slab unit may include an edge frame which may provide for the inclusion of a suitable decking and surfacing. In tests, erection of the apparatus to a secure state of flood defence using a slab unit approximately 3 metres long took unskilled labour only 3 minutes to complete.

In order to vary the height of a flood barrier when the slab unit is in its raised position, the centre of gravity of a slab unit may be varied by, for example, rearranging the slab unit's balancing weight(s), their support brackets and/or the space occupied by the weight(s).

The slab unit of the apparatus preferably forms at least part of a paved way when in its lowered position. The paved way may comprise a pavement or footpath for pedestrians and/or a road for vehicles. Thus, the apparatus provides a dual function of providing a paved way when the at least one slab unit is lowered and providing at least part of a barrier for water retention when the at least one slab unit is raised.

The apparatus for flood defence may have a substantial portion of the base projecting above ground level so that the apparatus provides a first level of water retention for flood defence when the or each slab unit is in its lowered position and the apparatus is arranged to provide a higher second level of water retention for flood defence when the or each slab unit is in its raised position. The first level for flood defence is a passive defence and may comprise at least part of a shallow raised bund around part or all of the building(s) or land to be protected. The apparatus can be landscaped into the land or the grounds of a building such as a garden of a home. There would be no obstruction to the view

to the grounds of the building from a ground floor window when the apparatus is providing a first level for flood defence.

The base may comprise a channel which can act as a drainage duct. The base may comprise a mounting or upstand extending into the channel which supports the or each slab unit for rotation. The channel may have an integral downwardly projecting foundation portion.

The apparatus can have a full service life of 50 years and has cost advantages in relation to maintenance and to the number of people required to erect/lower the defence.

According to another aspect of the present invention there is provided a method for flood defence comprising the step of:

rotating at least one slab unit about an axis from a lowered position to a raised position so as to comprise at least part of a barrier for water retention when in the latter position, and characterized by the step of:

substantially balancing the at least one slab unit about the axis.

The apparatus and method requires no untried components.

An embodiment of the present invention will now be described, by way of example only, with reference to the accompanying schematic drawings, in which:-

Figure 1 is a schematic layout of a flood defence incorporating the apparatus according to a typical embodiment of the invention;

Figures 2A and 2B are schematic cross-sections of the apparatus illustrating the relationship of the active and passive defence measures of a typical embodiment of the invention;

Figure 3 is a cross-sectional view of the apparatus in a lowered position;

Figure 4 is a sectional view taken along lines 4 – 4 of Figure 3;

Figure 5 is a plan view of a frame for a slab unit of the apparatus;

Figures 6A and 6B are cross-sectional views of the slab unit taken along lines 6A – 6A and 6B – 6B of Figure 5, respectively;

Figure 7 is a cross-sectional view of the apparatus in a raised position;

Figures 8 and 9 are an elevational view and a sectional view, respectively, of the apparatus of Figure 7;

Figure 10 is a detail of a fine balancing device for the apparatus; and

Figure 11 is a sectional view taken along lines 11 – 11 of Figure 10.

Referring to Figures 1, 2A and 2B of the accompanying drawings, a domestic building 1 such as a house has a manual flood defence comprising the apparatus 2. The apparatus 2 comprises a plurality of slab units 3 rotatable about a horizontal axis 4 relative to a base 5 forming a channel structure 9 which can act as a drainage duct. The slab units 3 are shown in solid lines in a horizontal lowered position and in dotted line in a vertical raised position. The slab units 3 are laid out as a path in a straight line between two permanent abutments 6 or buttresses and are parallel to an embankment wall 7 of a river 8. Further apparatus 2' extends from each of the abutments 6 at any angle to the apparatus 2 as part of the flood defence.

Figures 2A and 2B illustrate the apparatus involved as an active/ passive defence sited in relation to existing ground and floor levels to be protected. Figure 2A indicates the benefits of employing a combined passive defence and active defence for resistance to flooding having a passive height (P) of the base 5 protruding above the ground and an active height (A) of the raised slab unit 3 above the base 5. The level of the base 5 or foundation may be sited such that a bund comprising the base 5 does not impair the view from the downstairs window of the house. The maximum height of a flood defence consisting of a combined active height (A) and a passive height (P) requires the floor 57 of the drainage duct 9 of the base 5 to be sited at least 15cm below the level of the floor 58 of the building 1 or land to be protected, so as to ensure a minimum facility to collect and pump away any penetrating water. Figure 2B illustrates the defence for a building or land where only an active defence is provided such as where a roadway is sited at natural ground level. In this situation, the slab units 3 are at existing or required ground level when in their lowered positions. The drainage duct 9 provides an automatic water collection facility for any water

penetrating the defence or rising through the ground behind the defence and the collected water can then be pumped away.

Referring to Figures 3 and 4, with the slab unit 3 in the horizontal, lowered position, the channel structure 9 has a dry side walls portion 10, a wet side wall portion 11 and a bottom portion 12. Within this channel structure 9 sit a plurality of metal constructions comprising identical sets 13 or mounts which are spaced at half the slab unit length and uniformly along the length of the channel structure 9. Each set comprises a pair of stub columns 14 supporting a bearer beam 15 which supports a bearing bracket 16 at one end and a locking block 17 is affixed to the other end. The slab unit 3 is supported in the horizontal position by the locking block 17 and by a bearing 19 housed within the bearing bracket 16. All such sets 13 in the construction are joined together by continuous foundation angles 20 bolted both to the stub columns 14 as well as the bottom portion 12 of the channel structure 9. Along the foundation angle 20 is affixed continuously a horizontal 'b' shaped hollow seal 21. The seal 21 is secured to the foundation angle 20 by bolting at regular intervals a seal fixing channel section 22. The assembly of bearing bracket 16 and bearing 19 carried by the bearer beam 15 extends within a housing 23 (see Fig. 5) in the thickness of the slab unit 3. At each set 13 position, the slab unit 3 is held in a locked position by a locking pin 18 secured to each locking block 17 and turned by a key (not shown) shaped uniquely to match the lock assembly. The slab unit 3 is finely balanced about the axis or hinge line 4 by the incorporation of appropriate unit balancing or counterweights 24 placed within the thickness of the slab unit 3 at the outermost edge facing the threat of flood.

Referring to Figures 5, 6A and 6B, the slab unit 3 has an edge frame formed by L-shaped members 25 and within which is a sub-assembly of members acting in support of a decking 26 which may, for example, comprise an asphalt top on a waterproof membrane or a layer of light concrete. Across the width of the slab unit 3 span two separate pairs of opposed bearing support angle members 27 to which is fixed a plate 28 on which the bearing 19 is fixed.

Parallel with the length of the slab unit 3 are back to back angle members 29 running the full length of slab unit 3 (except between the bearing support angle members 27) and supporting the counterweights 24. The counterweights 24 may be of precast concrete and be shaped to fit the angle members 29. Intermediate channel members 30 for supporting the decking 26 are parallel to the bearing support angle members 27 and span between the back to back angle member 29 facing the L-shaped member 25 parallel and furthest from the axis 4.

Within the housing 23 formed by the opposed bearing support angle members 27 is located a strut 31 capable of being extended a defined length. The strut 31 comprises a tube 32 (fitted with a turnbuckle 42 as shown on Figure 7) sliding snugly within a larger diameter tube 33. Tube 33 is closed at one end and is permanently secured at the closed end to the bearer beam 15 by a pin hinge 34. In the stowed position the free end of tube 32 is held securely horizontal by a clip 35, secured in turn to the bearer beam 15.

In order to form an active defence the slab unit 3 is unlocked from each of the locking blocks 17 using a key provided for this purpose. Referring to Figure 7 and considering all activity takes place from the side of the construction furthest from the threat, the finely balanced slab unit 3 is raised to the vertical position and pushed away (towards the threat) at the top so that the toe of the slab unit 3 impinges on the horizontal seal 21. This push is continued until a latch 37 or locking means attached to a stub column 14 adjacent the rotated slab unit 3 engages with the L-shaped member 25 at the toe of the slab unit 3, thus securing the slab unit 3 in the vertical position. The free end of each of the extending struts 31 are then pulled out of the clips 35 and raised up. Tube 32 is pulled out of tube 33 until holes 36 in both tubes are coincident. Pins 38 are then inserted through the coincident holes 36 to lock the strut 31 to the required length and spring clips 39 inserted in holes in the pins to ensure the security of the fixing.

Referring to Figure 8, the free end of the strut 31, comprising a small

plate 40 connected to the tube 32, is then placed within the two sides of a projecting channel shaped bracket 41 on the face of the slab unit 3 and secured with a pin 38 and spring clip 39. The turnbuckle 42 is then rotated either way to ensure the strut 31 is properly secured and engaged with the top of the slab unit 3 such that the junction between adjacent slab units 3 is aligned correctly.

Referring to Figures 8 and 9, in order to form the vertical seal between adjacent slab units 3 a sealing board 43 is inserted in each gap 44 between adjacent slab units 3. Each gap 44 is formed between opposing L-shaped members 25 forming part of the edge frame of each adjacent slab unit 3. Each opposing L-shaped member 25 has an angle member 45 fitted therein so that the combined L-shaped member 25 and angle member 45 forms a channel. The sealing board 43 is the length of the width of the slab unit 3 and the width of the sealing board 43 is such that it can be admitted into the gap between the opposing angle members 45. The sealing board 43 is placed into the gap 44, rotated so that one face 56 of the sealing board 43 faces the returns on the two opposing angle members 45 and lowered until the board 43 is stopped by a toe plate 50 fitted at the bottom end of each perimeter angle member 25. The bottom portion of the sealing board 43 faces the horizontal seal 21 and the board 43 is brought into contact with the returns on the two opposing angle members 45. The contact surfaces of the sealing board 43 are fitted with seals 46 along the length of the board 43 and are aligned with corresponding seals 46 on the returns on the opposing angle members 45. The sealing board 43 is fitted with several clamping devices 47 whereby a loose, but captive, flat plate 48 is tightened by a hand operated butterfly nut 49. The sealing board 43 is tightened against the opposing angle members 45 by turning the flat plates 48 so that they engage with the face of the angle members 45 on the opposite side to the contact surfaces facing the sealing board 43. The butterfly nuts 49 are then turned so as to press the plates 48 firmly against the angle members 45 and clamp the sealing board 43 into position so that the vertical seals 46 of the sealing board 43 and angle members 45 are clamped together, and so that the

seals 46 are also clamped against the horizontal seal 21 in order to effectively plug the gap between the opposing angle members 45.

The gap between each abutment 6 (see Figure 1) and an adjacent slab unit 3 are sealed in the same way and when the last of the clamping devices 47 is fixed the defence is completed.

Any water which seeps between adjacent raised slab units 3 or a raised slab unit 3 and an adjacent abutment 6 is collected in the channel structure 9 which acts as drainage duct from where it can be pumped away.

Restoring the defence to the horizontal position involves the identical procedure in the reverse order of activity. When not in use, the sealing board 43 is stowed in the channel structure 9 under the slab unit 3 when the slab unit 3 is in its horizontal, lowered position and the sealing board 43 is retrieved from there when the active defence is to be formed again. Apart from the sealing board 43 all fittings required for the defence are permanently connected to the sets 13, thus requiring no additional materials or equipment to be delivered in the period of erection prior to the onset of a flood. All components required for erection, dismantling and safety during a flood are fixed or stored under the slab units such that they are always available for use except, obviously, for the key to unlock the slab unit 3 from the locking block 17.

It is an inherent requirement of the apparatus that each of the separate slab units 3 are finely balanced to give a slight imbalance towards the end (which swings down) facing the flood threat. To achieve this effect a preferred embodiment uses a mobile weight independently of the counterweights. Referring to Figures 10 and 11, the weight 51 is bolted to a metal plate 53 which is fitted with two lugs 54 which each have a threaded hole 55. The plate 53 is clamped to the intermediate channel members 30 which are fixed within the framework of the L-shaped angle members 25. Clamping is achieved by tightening a bolt 52 through the threaded hole 55 in the plate lug 54 against the return on the channel member 30. The position of the weight 51 is determined when, using the optimum number of counterweights 24, the slab unit 3 is in

complete (finger lift) balance in the horizontal position. The adjustable position of the mobile balancing weight 51 provides full flexibility for balance.

The slab units 3 can have any required finish. In a typical embodiment, each slab unit 3 is approximately 3 metres long, 1.5 metres wide and 15 centimetres thick. The dimensions of L-shaped members 25 are 150 x 90 mm, and the deck 26 used is 6 mm thick. The bearings 19 comprise standard units available from normal suppliers. The channel 9 is formed from reinforced concrete. The sealing board 43 is of high density plastic and has the dimensions 1500 x 150 x 20 mm.

The depth of the footing below the bottom portion 12 of the channel structure 9 is determined from a site investigation of the permeability of the soil and its strength characteristics to prevent the apparatus 2 from sliding or tilting.

Whilst a particular embodiment has been described, it will be understood that various modifications may be made without departing from the scope of the invention. For example, a variety of structural materials may be used for ease of construction, suitability in corrosive ground conditions, long life maintenance free characteristics and the economics of the installation. The vertical seal between adjacent slab units or a slab unit and an adjacent abutment may comprise a board housed within the space afforded by the edge detail of juxta-opposed slab units or a slab unit and abutment and fixed by hinging or other means so as to be positioned in conjunction with seals in order to form a waterproof joint. Also, additional measures to supplement the apparatus may be used such as pumps, which may be portable, to pump out any leakage around the seals via a continuous ducting system on the dry side of the dam. Sumps may be strategically placed for the use of the portable pumps to keep the flow of water in the duct at an acceptable level. The size of the duct of the channel structure 9 is selected to suit the requirements of ancillary works for the apparatus, together with the need to accommodate other services such as electrical/communication services and pipework.

The size of the apparatus may be adjusted to suit factors such as sloping ground, required height of the barrier and the length of the paved way. All support structures for the slab units, their bearings and strutting devices, together with any ducting, are subject to individual workings and site conditions.